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TEST REPORT

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KCTL

1. Client

- Name : Starnex Co., Ltd.
- Address : #201, Kolon Digital Tower Aston, 212, Gasan Digital 1-ro, Geumcheon-gu, Seoul, South Korea
- Date of Receipt : 2020-04-27

2. Use of Report : Certification

3. Name of Product and Model : Social Talkie E1 / ST-E1

4. Manufacturer and Country of Origin : Starnex Co., Ltd. / Korea

5. FCC ID : TN9ST-E1

6. Date of Test : 2016-05-20 to 2016-05-24

7. Location of Test : ■ Permanent Testing Lab □ On Site Testing (Address: Address of testing location)

8. Test Standards : FCC Part 15 Subpart C, 15.247

9. Test Results : Refer to the test result in the test report

Affirmation	Tested by Name : Euijung Kim (Signature)	Technical Manager Name : Heesu Ahn (Signature)

2020-06-15

KCTL Inc.

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

REPORT REVISION HISTORY

Date	Revision	Page No
2020-06-15	Originally issued	-

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General remarks for test reports

Nothing significant to report.

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1. General information

Client	:	Starnex Co., Ltd.
Address	:	#201, Kolon Digital Tower Aston, 212, Gasan Digital 1-ro, Geumcheon-gu, Seoul, South Korea
Manufacturer	:	Starnex Co., Ltd.
Address	:	#201, Kolon Digital Tower Aston, 212, Gasan Digital 1-ro, Geumcheon-gu, Seoul, South Korea
Laboratory	:	KCTL Inc.
Address	:	65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
Accreditations	:	FCC Site Designation No: KR0040, FCC Site Registration No: 687132 VCCI Registration No. : R-20080, G-20078, C-20059, T-20056 Industry Canada Registration No. : 8035A KOLAS No.: KT231

2. Device information

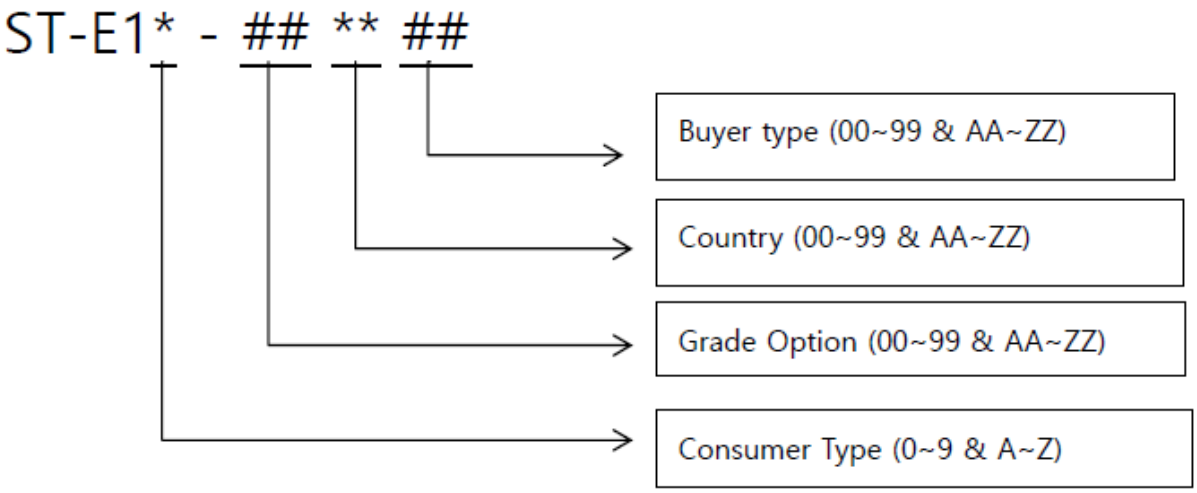
Equipment under test	:	Social Talkie E1
Model	:	ST-E1
Derivative model	:	Please refer to Section 2.2
Modulation technique	:	4GFSK, FHSS
Number of channels	:	22 ch (4GFSK), 250 ch (Half mode), 50 ch (Hi-fi mode)
Power source	:	DC 3.7 V
Antenna specification	:	Internal Antenna
Antenna gain	:	-0.95 dBi
Frequency range	:	905.0 ㎒ ~ 926.0 ㎒ (4GFSK) 902.6 ㎒ ~ 927.5 ㎒ (Half mode), 903.0 ㎒ ~ 927.5 ㎒ (Hi-fi mode)
Software version	:	01.10.01 (4GFSK), 01-02-04 (FHSS)
Hardware version	:	0X000000F1.1 (4GFSK), V07 (FHSS)
Test device serial No.	:	Conducted(24672d0558451dbf), Radiated(24906t075dd26318)
Operation temperature	:	-20 ℃ ~ 60 ℃

2.1. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source	FCC ID
N/A	-	-	-	-	-

2.2. Model Information

The difference between basic model and derivative model is:



2.3. Frequency/channel operations

This device contains the following capabilities:
4GFSK, FHSS

Half mode

Ch.	Frequency (㎒)
Low	902.6
Middle	915.0
High	927.5

Hi-fi mode

Ch.	Frequency (㎒)
Low	903.0
Middle	915.0
High	927.5

Table 2.3.1. FHSS mode

15.247 Requirements for Hopping transmitter:

1) This system is hopping pseudo-randomly.
2) Each frequency is used equally on the average by each transmitter.
3) The receiver input bandwidths that match the hopping channel bandwidths of their corresponding transmitters
4) The receiver shifts frequencies in synchronization with the transmitted signals.

- 15.247(g): The system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this Section 15.247 should the transmitter be presented with a continuous data (or information) stream.
- 15.247(h): The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

3. Antenna requirement

Requirement of FCC part section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

- The transmitter has permanently attached Internal Antenna on board.

4. Summary of tests

FCC Part section(s)	Parameter	Test results
15.247(b)(1), (4)	Maximum peak output power	Pass
15.247(a)(1)	Carrier frequency separation	Pass
15.247(a)(1)	20dB channel bandwidth	Pass
15.247(a)(iii) 15.247(b)(1)	Number of hopping channel	Pass
15.247(a) (iii)	Time of occupancy(dwell time)	Pass
15.205(a), 15.209(a) 15.247(d),	Spurious emission	Pass
	Band-edge, restricted band	Pass
15.207(a)	Conducted Emissions	Pass

Notes:

1. The data documented in this new DSS report (FCC ID: TN9ST-E1) are exactly same as the data documented in another certified DSS report (FCC ID: TN9DOMINOE1 and report no: KCTL16-SFR0052). The two devices are electronic and electrically identical - the new DSS grant is to enable the 4GFSK mode via software without other changes and does not affect the existed frequency hopping section.
2. All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
3. According to exploratory test no any obvious emission were detected from 9 ㎑ to 30 ㎒. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
4. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that **X** orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in **X** orientation.
5. The test procedure(s) in this report were performed in accordance as following.
   - ANSI C63.10-2013
   - KDB 558074 D01 v05r02

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5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k=2 to indicated a 95 % level of confidence. The measurement data shown herein meets of exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty (±)	
Conducted RF power	1.44 dB	
Conducted spurious emissions	1.52 dB	
Radiated spurious emissions	30 MHz ~ 300 MHz	+ 4.94 dB, - 5.06 dB
		+ 4.93 dB, - 5.05 dB
	300 MHz ~ 1 000 MHz	+ 4.97 dB, - 5.08 dB
		+ 4.84 dB, - 4.96 dB
	1 GHz ~ 25 GHz	+ 6.03 dB, - 6.05 dB
Conducted emissions	9 kHz ~ 150 kHz	3.75 dB
	150 kHz ~ 30 MHz	3.36 dB

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6. Measurement results explanation example

Frequency (㎒)	Factor(㏈)	Frequency (㎒)	Factor(㏈)
30	9.67	1 000	10.85
50	9.79	2 000	11.07
100	10.02	3 000	11.99
200	10.19	4 000	12.05
300	10.28	5 000	11.83
400	10.38	6 000	11.46
500	10.45	7 000	11.34
600	10.51	8 000	11.99
700	10.58	9 000	11.96
800	10.73	10 000	11.91
900	10.80	-	-

Note.
Offset(㏈) = RF cable loss(㏈) + Power Divider(㏈) + Attenuator(㏈)

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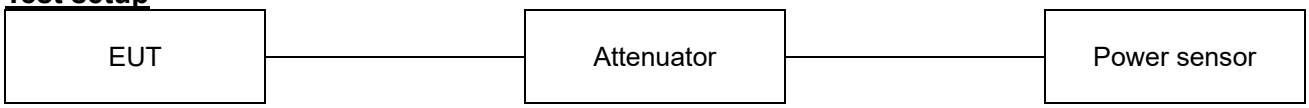
7 Test results

7.1. Maximum peak output power

Test setup



Limit

According to §15.247(b)(2), for frequency hopping systems operating in the 902-928 ㎒ band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

Test procedure

ANSI C63.10-2013 - Section 7.8.5

Test settings

The test follows ANSI C63.10-2013 – Section 7.8.5. Using the power sensor instead of a spectrum analyzer.

A peak responding power sensor is used, where the power sensor system video bandwidth is greater than the occupied bandwidth of the EUT.

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Test results

-Half mode

Frequency(㎒)	Data rate(kbps)	Measured output power(dBm)		Limit(dBm)
		Peak	Average	
902.6	12.4	19.68	19.57	30.00
915.0	12.4	19.78	19.65	
927.5	12.4	19.68	19.52	

-Hi-fi mode

Frequency(㎒)	Data rate(kbps)	Measured output power(dBm)		Limit(dBm)
		Peak	Average	
903.0	100	19.68	18.49	30.00
915.0	100	19.78	18.52	
927.5	100	19.68	18.40	

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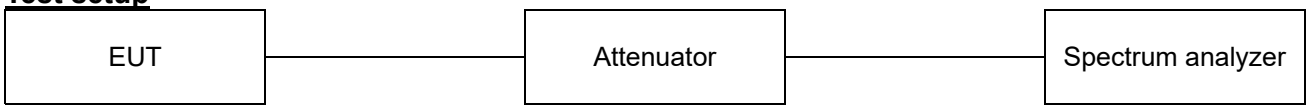
7.2. Carrier frequency separation

Test setup



Limit

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2 400-2 483.5 ㎒ band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-thirds of the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

Test procedure

ANSI C63.10-2013 - Section 7.8.2

Test settings

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels.
Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

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Test results

-Half mode

Frequency(㎒)	Data rate(kbps)	Carrier frequency separation(㎒)	Limit(㎒)
902.6	12.4	0.100	≥25 ㎑ or 20 ㏈bandwidth
915.0	12.4	0.100	
927.5	12.4	0.100	

-Hi-fi mode

Frequency(㎒)	Data rate(kbps)	Carrier frequency separation(㎒)	Limit(㎒)
903.0	100	0.502	≥25 ㎑ or 20 ㏈bandwidth
915.0	100	0.502	
927.5	100	0.502	

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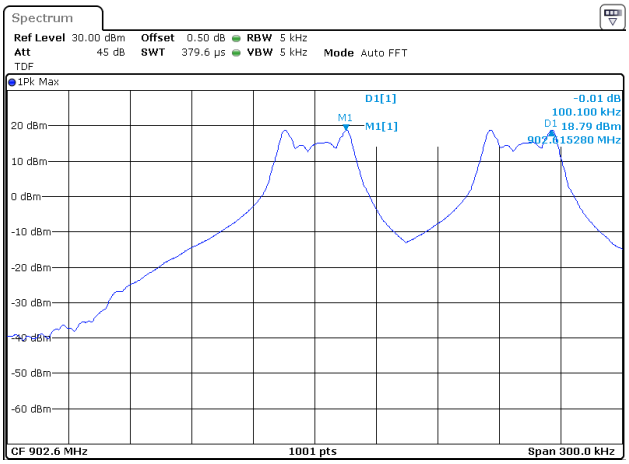
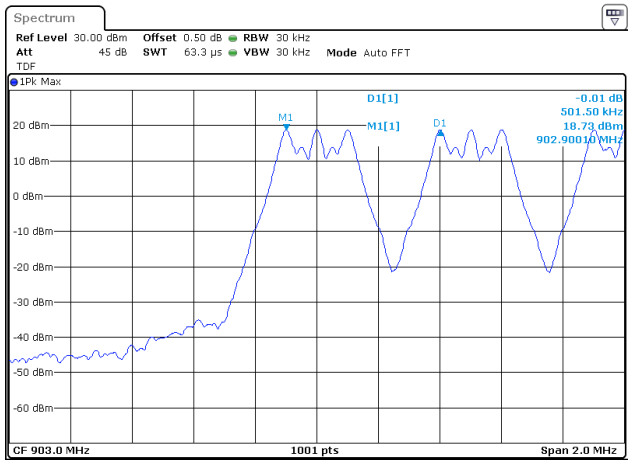
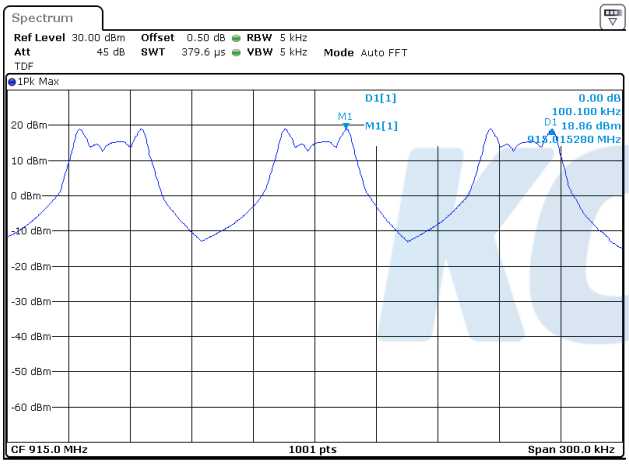
Half mode / Low ch.



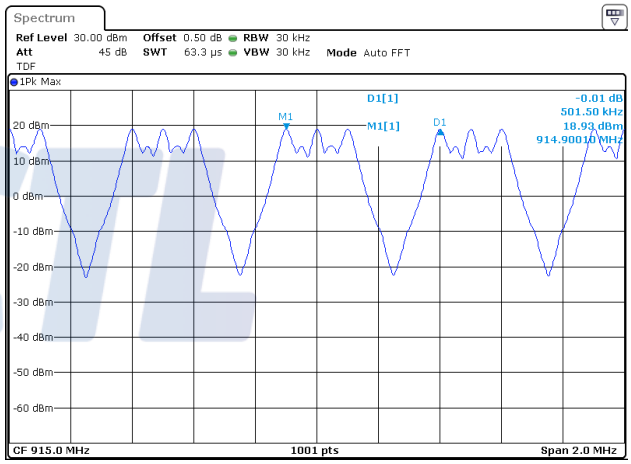
Hi-fi mode / Low ch.



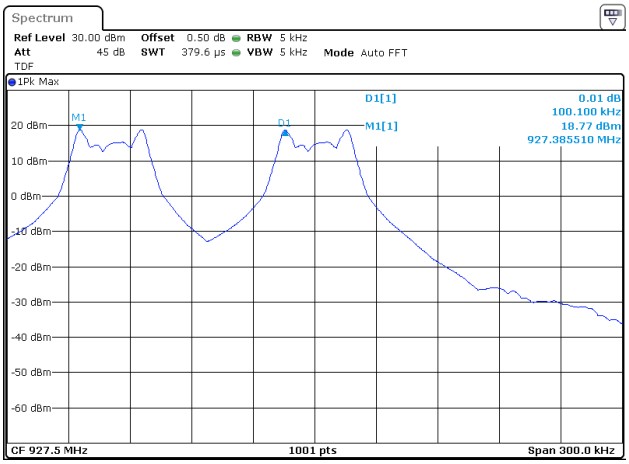
Half mode / Mid ch.



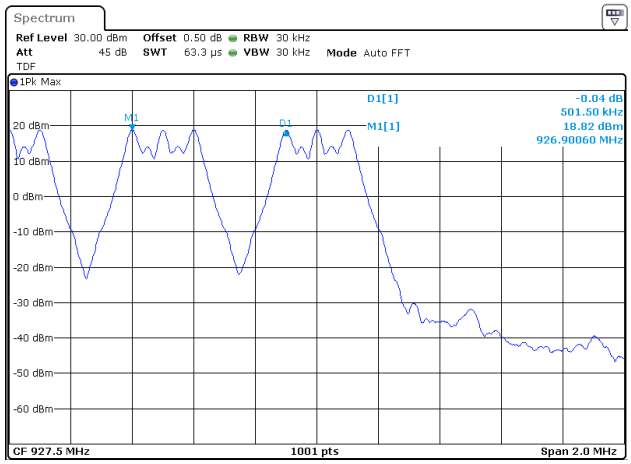
Hi-fi mode / Mid ch.



Half mode / High ch.



Hi-fi mode / High ch.



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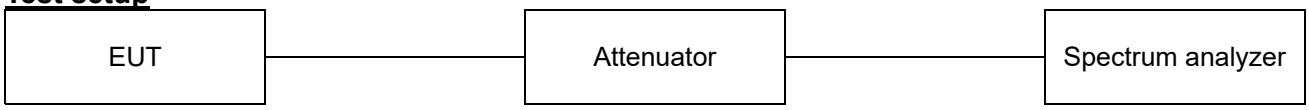
7.3. 20dB channel bandwidth

Test setup



Limit

According to §15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 ㎒ band: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 ㏈ bandwidth of the hopping channel is 250 ㎑ or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 ㏈ bandwidth of the hopping channel is 500 ㎑.

Test procedure

ANSI C63.10-2013 - Section 6.9.2

Test settings

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of ㏈ down from the reference value). Typical ratios, expressed in dB, are −6 ㏈, −20 ㏈, and −26 ㏈, corresponding to 6 ㏈ BW, 20 ㏈ BW, and 26 ㏈ BW, respectively. In this subclause, the ratio is designated by "−xx ㏈." The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the "−xx ㏈" bandwidth; other requirements might specify that the "−xx ㏈" bandwidth be entirely contained within the authorized or designated frequency band.

a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency.
b)Span: Two times and five times the OBW.
c) RBW = 1 % to 5 % of the OBW and VBW ≥ 3 x RBW
d) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation.
e) The dynamic range of the instrument at the selected RBW shall be more than 10 ㏈ below the target "−xx ㏈ down" requirement; that is, if the requirement calls for measuring the −20 ㏈ OBW, the instrument noise floor at the selected RBW shall be at least 30 ㏈ below the reference value.
f) Detector: peak
g) Trace mode: max hold.
h) Allow the trace to stabilize.
i) Determine the "−xx ㏈ down amplitude" using ((reference value) − xx). Alternatively, this calculation may be made by using the marker-delta function of the instrument.
j) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
k) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "−xx ㏈ down amplitude" determined in step h). If a marker is below this "−xx ㏈ down amplitude" value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference

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between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the "−xx dB down amplitude" determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.

Test results

-Half mode

Frequency(㎒)	Data rate (kbps)	20 dB Bandwidth (㎒)
902.6	12.4	0.040
915.0	12.4	0.040
927.5	12.4	0.040

-Hi-fi mode

Frequency(㎒)	Data rate (kbps)	20 dB Bandwidth (㎒)
903.0	100	0.311
915.0	100	0.311
927.5	100	0.311

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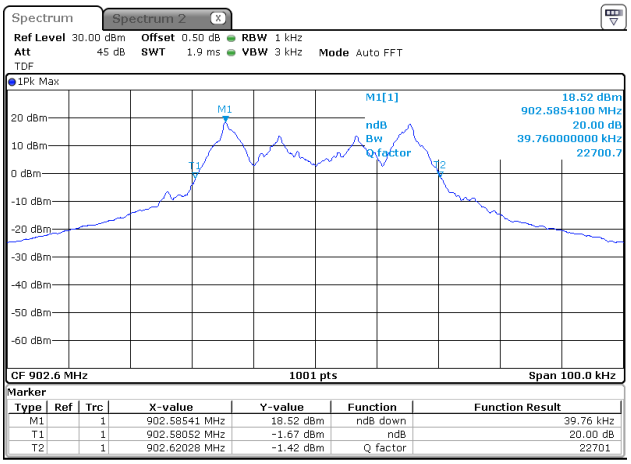
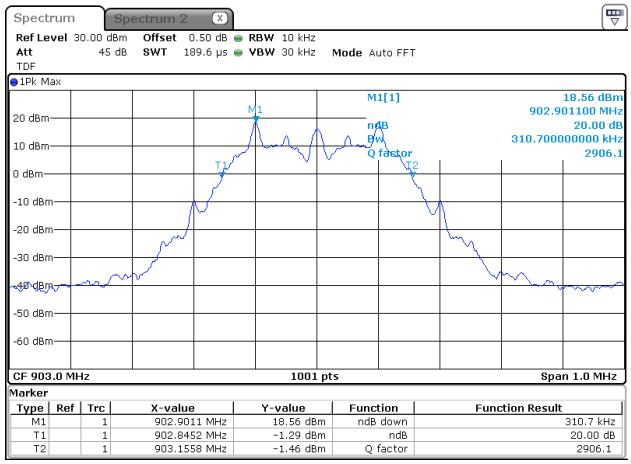
20 dB bandwidth(㎒)

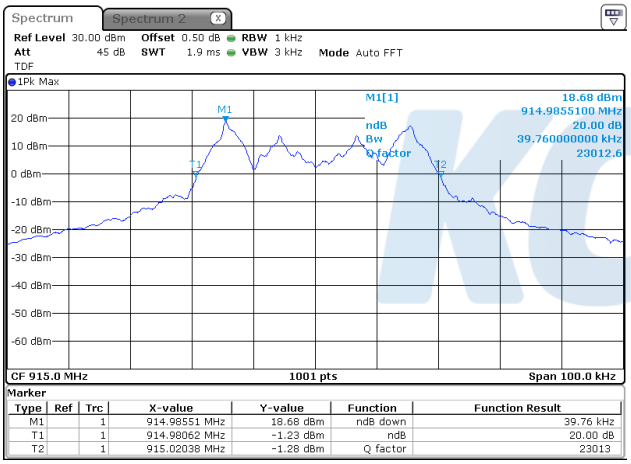
Half mode / Low ch.



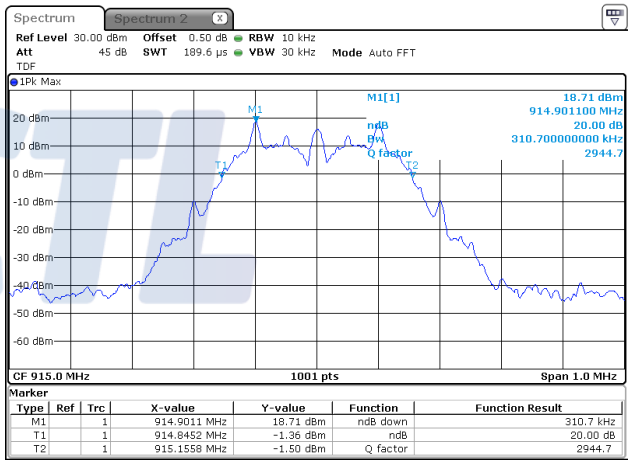
Hi-fi mode / Low ch.



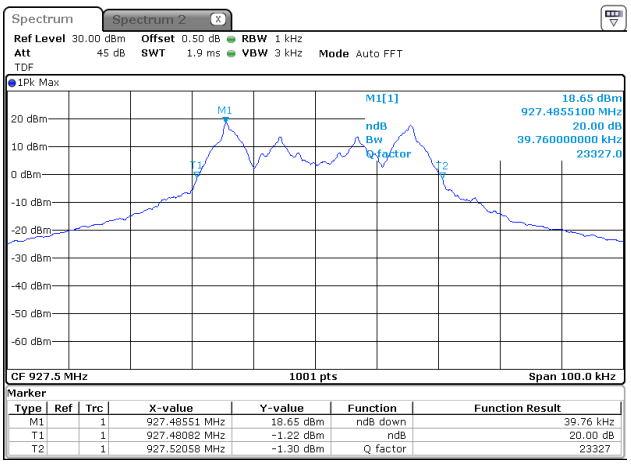
Half mode / Mid ch.



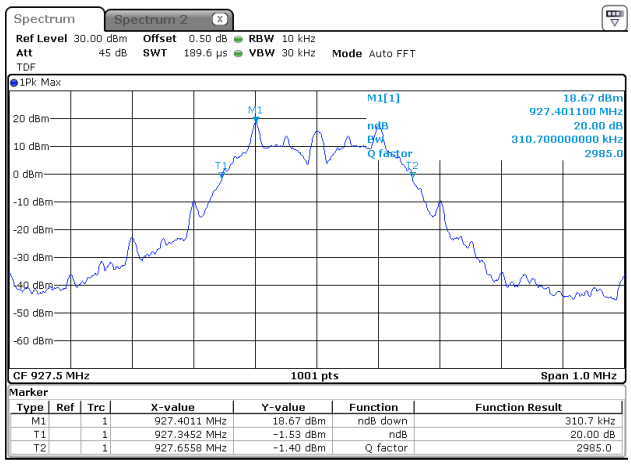
Hi-fi mode / Mid ch.



Half mode / High ch.



Hi-fi mode / High ch.



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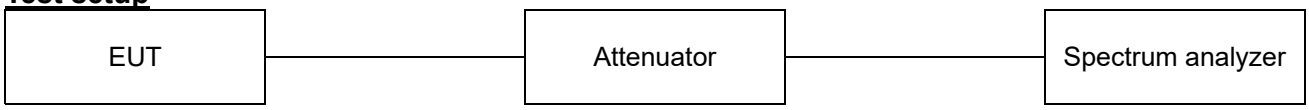
7.4. Number of hopping channels

Test setup



Limit

According to §15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 ㎒ band: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 ㏈ bandwidth of the hopping channel is 250 ㎑ or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 ㏈ bandwidth of the hopping channel is 500 ㎑.

According to §15.247(b)(2), For frequency hopping systems operating in the 902-928 ㎒ band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Test procedure

ANSI C63.10-2013 - Section 7.8.3

Test settings

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW: To identify clearly the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 ㏈ bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

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Test results

Mode	Hopping Group	Number of hopping channel	Limit
Half	(1)	50	≥50
	(2)	50	≥50
	(3)	50	≥50
	(4)	50	≥50
	(5)	50	≥50
Hi-fi	(5)	50	≥25

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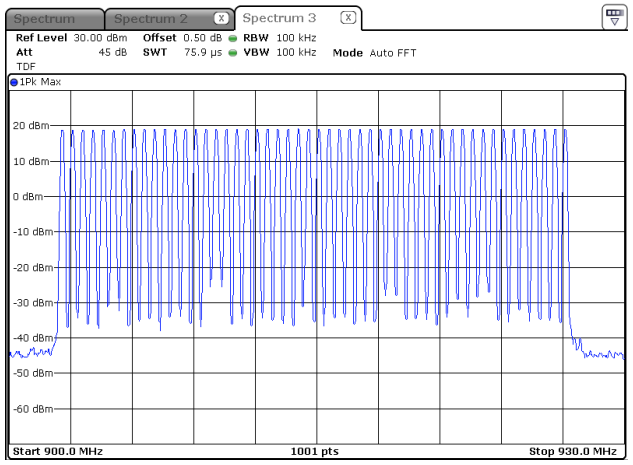
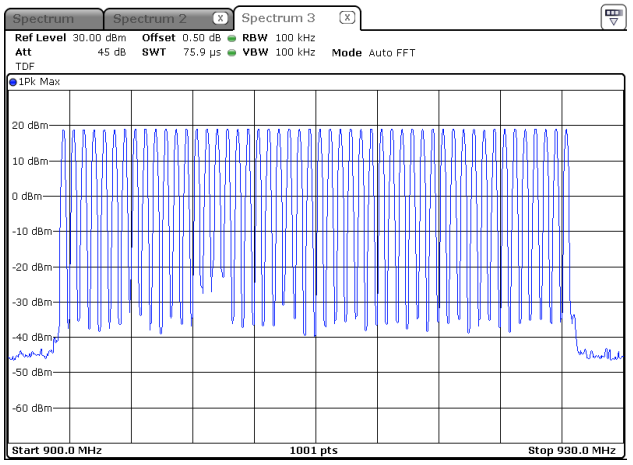
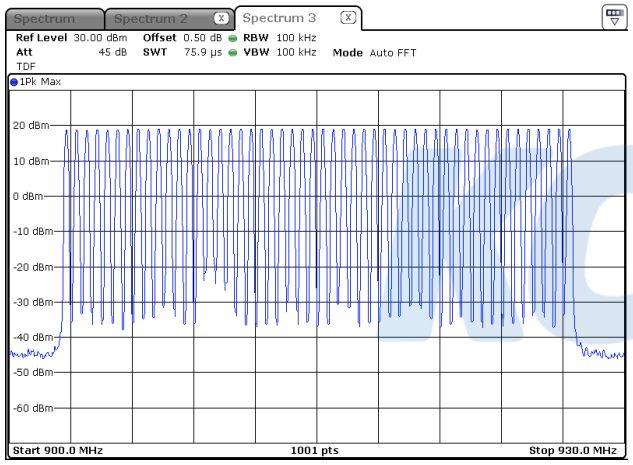
Half mode / Hopping Group(1)



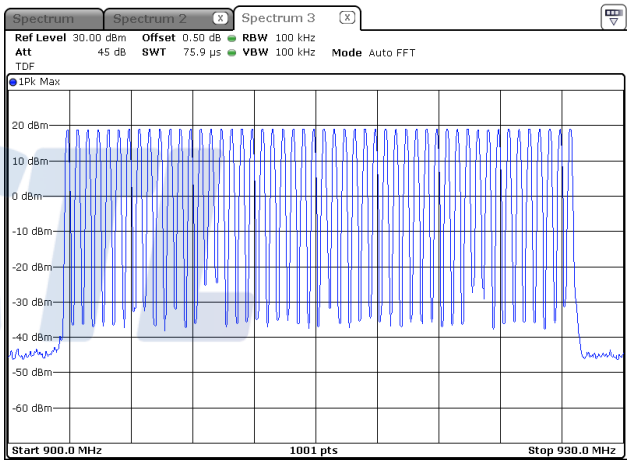
Half mode / Hopping Group(2)



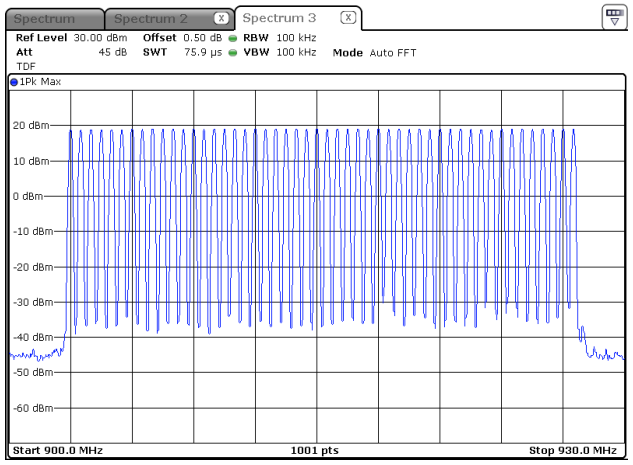
Half mode / Hopping Group(3)



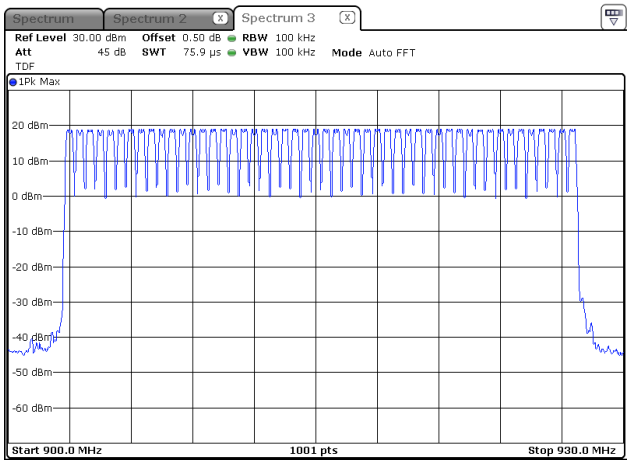
Half mode / Hopping Group(4)



Half mode / Hopping Group(5)

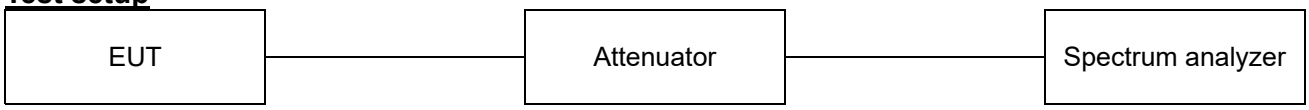


Hi-fi mode / Hopping Group(5)



7.5. Time of occupancy(Dwell time)

Test setup



Limit

According to §15.247(a)(1)(i), for frequency hopping systems operating in the 902-928 ㎒ band: If the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 ㏈ bandwidth of the hopping channel is 250 ㎑ or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 ㏈ bandwidth of the hopping channel is 500 ㎑.

Test procedure

ANSI C63.10-2013 - Section 7.8.4

Test settings

a) Span: Zero span, centered on a hopping channel.
b) RBW ≤ channel spacing and >> 1 / T, where T is the expected dwell time per channel.
c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function: Peak.
e) Trace: Max hold.
f) Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

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Test results

- Half mode

Hopping Group	Frequency (㎒)	Pulse Width (㎳)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
(1)	914.6	26.478	37.554	50	0.398	0.40
(2)	914.7	26.478	37.554	50	0.398	0.40
(3)	914.8	26.478	37.554	50	0.398	0.40
(4)	914.9	26.478	37.554	50	0.398	0.40
(5)	915.0	26.478	37.554	50	0.398	0.40

- Hi-fi mode

Hopping Group	Frequency (㎒)	Pulse Width (㎳)	Hopping rate (hop/s)	Number of Channels	Result (s)	Limit (s)
(5)	915.0	7.760	99.858	50	0.155	0.40

Notes:

1. Half mode
   - Period Time: 1.331 41 sec
   - Hopping Rate: 50 channels / Period Time
   - Result (s)= (Hopping rate (hop/s/slot) / 50 channels) x 20 sec x Pulse width (ms)
2. Hi-fi mode
   - Period Time: 0.500 712 sec
   - Hopping Rate: 50 channels / Period Time
   - Result (s)= (Hopping rate (hop/s/slot) / 20 channels) x 10 sec x Pulse width (ms)

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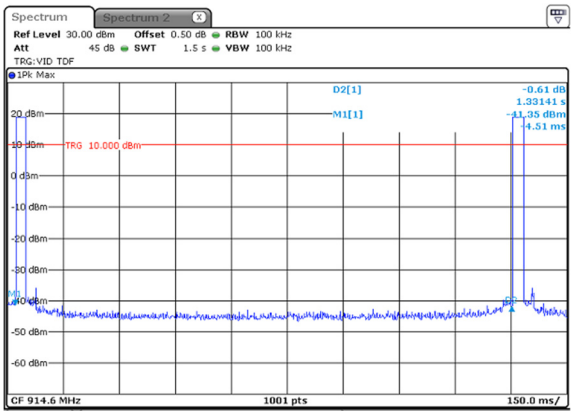
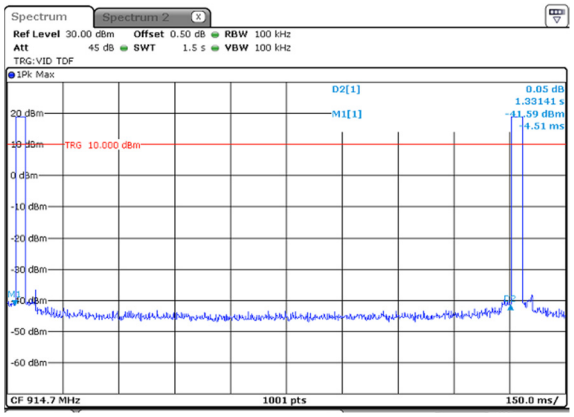
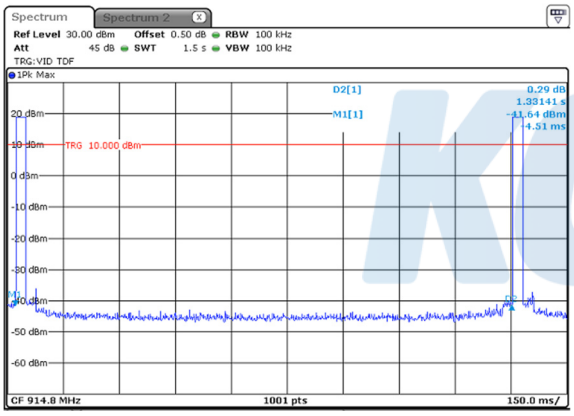
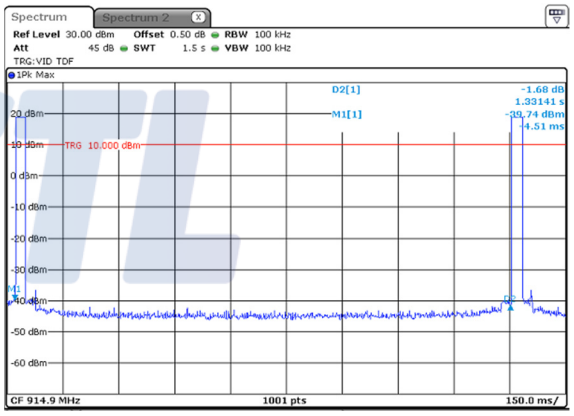
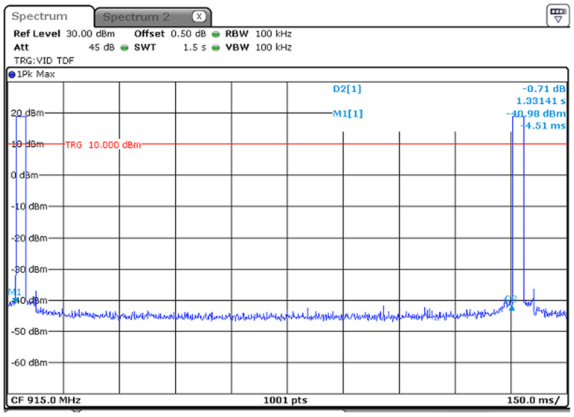
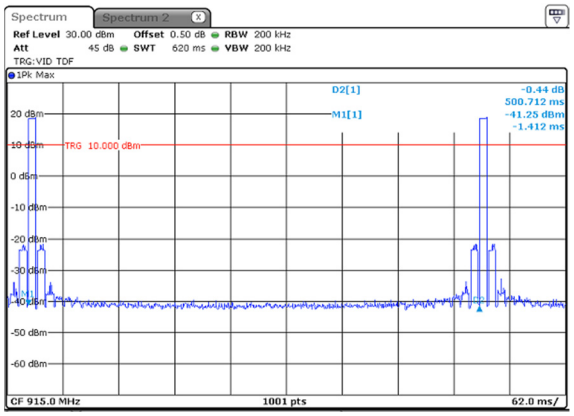
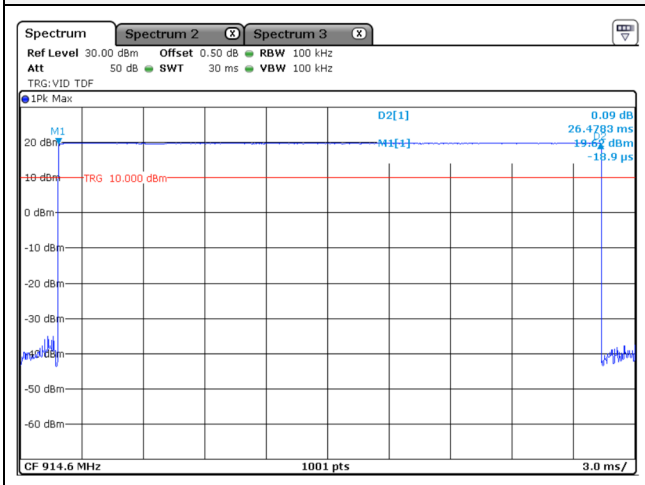
Period Time

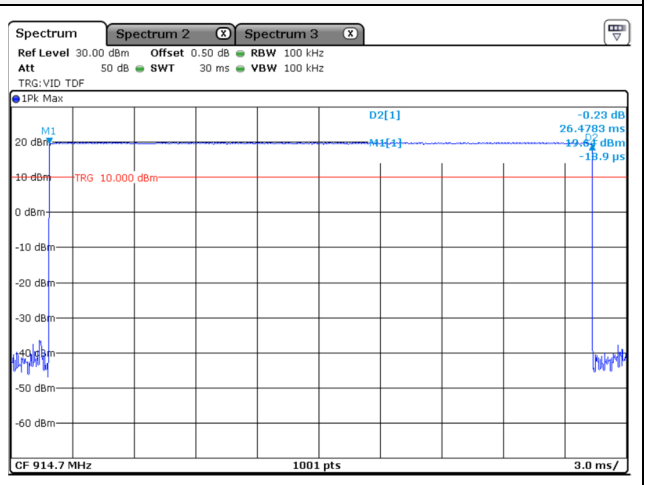
Half mode / Hopping Group(1)	Half mode / Hopping Group(2)
	
Half mode / Hopping Group(3)	**Half mode / Hopping Group(4)**
	
Half mode / Hopping Group(5)	**Hi-fi mode / Hopping Group(5)**
	

Pulse Width

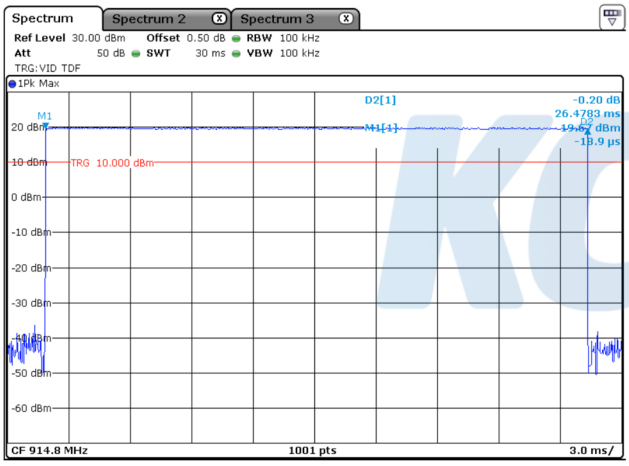
Half mode / Hopping Group(1)



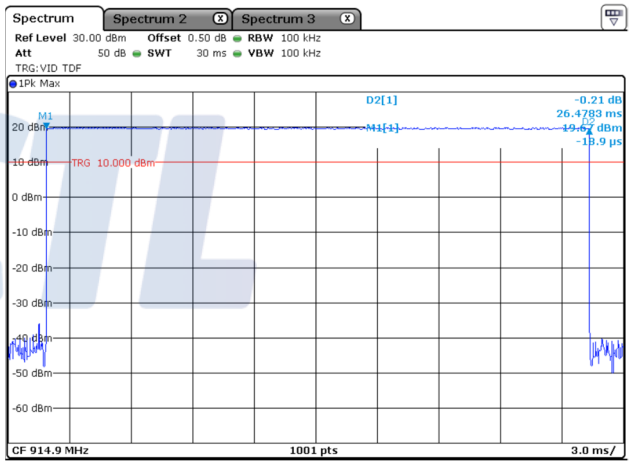
Half mode / Hopping Group(2)



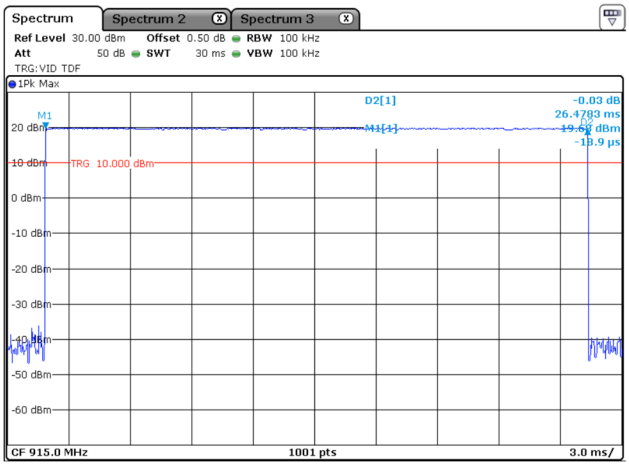
Half mode / Hopping Group(3)



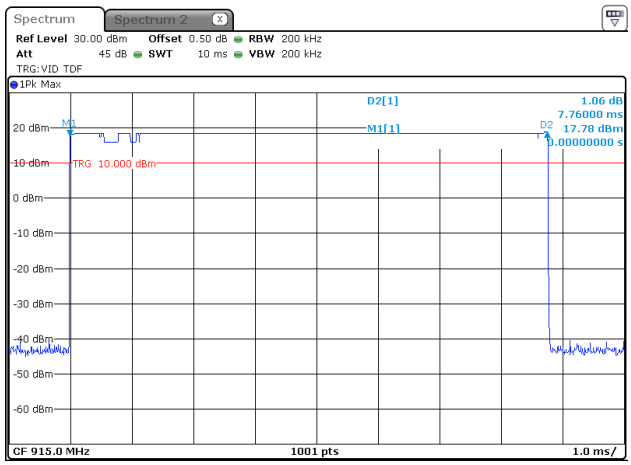
Half mode / Hopping Group(4)



Half mode / Hopping Group(5)



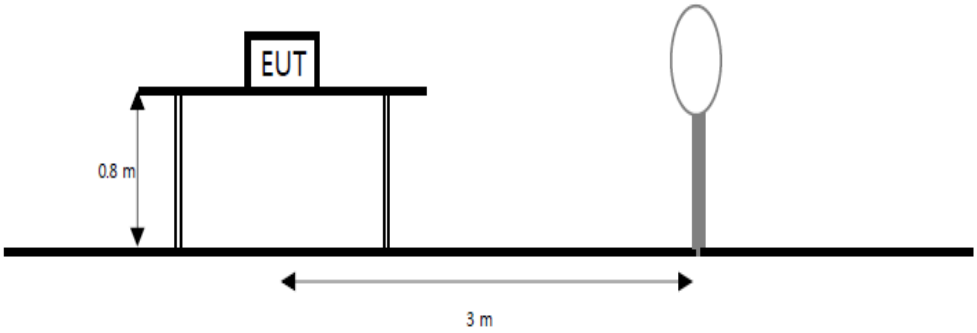
Hi-fi mode / Hopping Group(5)



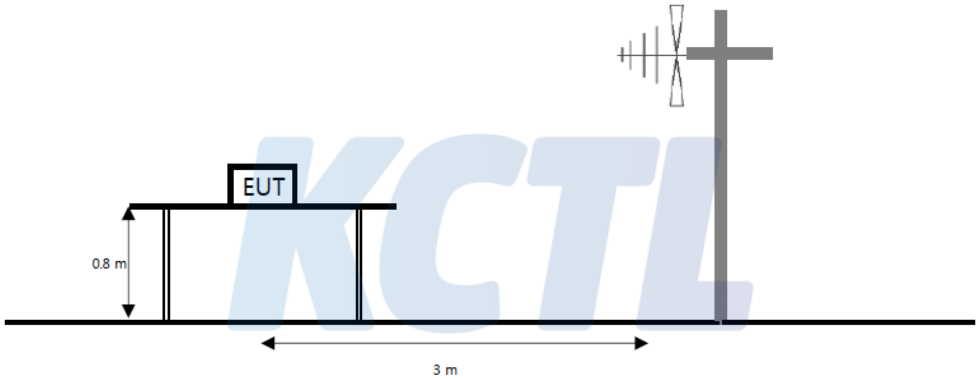
7.6. Radiated spurious emissions & band edge

Test setup

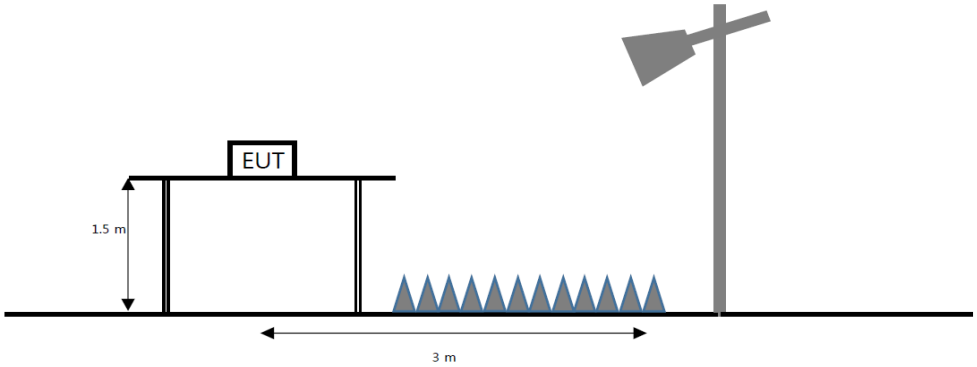
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓ emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Limit

According to section 15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Field strength (㎶/m)	Measurement distance (m)
0.009 - 0.490	2 400/F(㎑)	300
0.490 - 1.705	24 000/F(㎑)	30
1.705 - 30	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 ㎒, 76–88 ㎒, 174–216 ㎒ or 470–806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., Section15.231 and 15.241.

According to section 15.205(a) and (b), only spurious emissions are permitted in any of the frequency bands listed below:

㎒	㎒	㎒	㎓
0.009 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.694 75 - 16.695 25	608 - 614	5.35 - 5.46
2.173 5 - 2.190 5	16.804 25 - 16.804 75	960 – 1 240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1 300 – 1 427	8.025 - 8.5
4.177 25 - 4.177 75	37.5 - 38.25	1 435 – 1 626.5	9.0 - 9.2
4.207 25 - 4.207 75	73 - 74.6	1 645.5 – 1 646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1 660 – 1 710	10.6 - 12.7
6.267 75 - 6.268 25	108 - 121.94	1 718.8 – 1 722.2	13.25 - 13.4
6.311 75 - 6.312 25	123 - 138	2 200 – 2 300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2 310 – 2 390	15.35 - 16.2
8.362 - 8.366	156.524 75 - 156.525 25	2 483.5 – 2 500	17.7 - 21.4
8.376 25 - 8.386 75	156.7 - 156.9	2 690 – 2 900	22.01 - 23.12
8.414 25 - 8.414 75	162.012 5 - 167.17	3 260 – 3 267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3 332 – 3 339	31.2 - 31.8
12.519 75 - 12.520 25	240 - 285	3 345.8 – 3 358	36.43 - 36.5
12.576 75 - 12.577 25	322 - 335.4	3 600 – 4 400	Above 38.6
13.36 - 13.41			

The field strength of emissions appearing within these frequency bands shall not exceed the limits shown in section 15.209. At frequencies equal to or less than 1 000 ㎒, compliance with the limits in section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1 000 ㎒, compliance with the emission limits in section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in section 15.35 apply to these measurements.

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Test procedure
ANSI C63.10-2013

Test settings
Peak field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in table
3. VBW ≥ (3×RBW)
4. Detector = peak
5. Sweep time = auto
6. Trace mode = max hold
7. Allow sweeps to continue until the trace stabilizes

Table. RBW as a function of frequency

Frequency	RBW
9 ㎑ to 150 ㎑	200 ㎐ to 300 ㎐
0.15 ㎒ to 30 ㎒	9 ㎑ to 10 ㎑
30 ㎒ to 1 000 ㎒	100 ㎑ to 120 ㎑
> 1 000 ㎒	1 ㎒

Average field strength measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1 ㎒
3. VBW = 1/T ≥ 1 ㎐
4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
5. Detector = peak
6. Sweep time = auto
7. Trace mode = max hold
8. Trace was allowed to run for at least 50 times(1/duty cycle) traces

Notes:

1. *f* <30 ㎒, extrapolation factor of 40 ㏈/decade of distance. $F_d = 40\log(D_m/Ds)$
   f ≥30 ㎒, extrapolation factor of 20 ㏈/decade of distance. $F_d = 20\log(D_m/Ds)$
   Where:
   F_d= Distance factor in ㏈
   D_m= Measurement distance in meters
   D_s= Specification distance in meters
2. Factors(㏈) = Antenna factor(㏈/m) + Cable loss(㏈) + or Amp. gain(㏈) + or F_d(㏈)
3. The worst-case emissions are reported however emissions whose levels were not within 20 ㏈ of respective limits were not reported.
4. Average test would be performed if the peak result were greater than the average limit.
5. [1)] mean is restricted band.
6. According to part 15.31(f)(2), an extrapolation factor of 40 dB/decade is applied because measured distance of radiated emission is 3 m.

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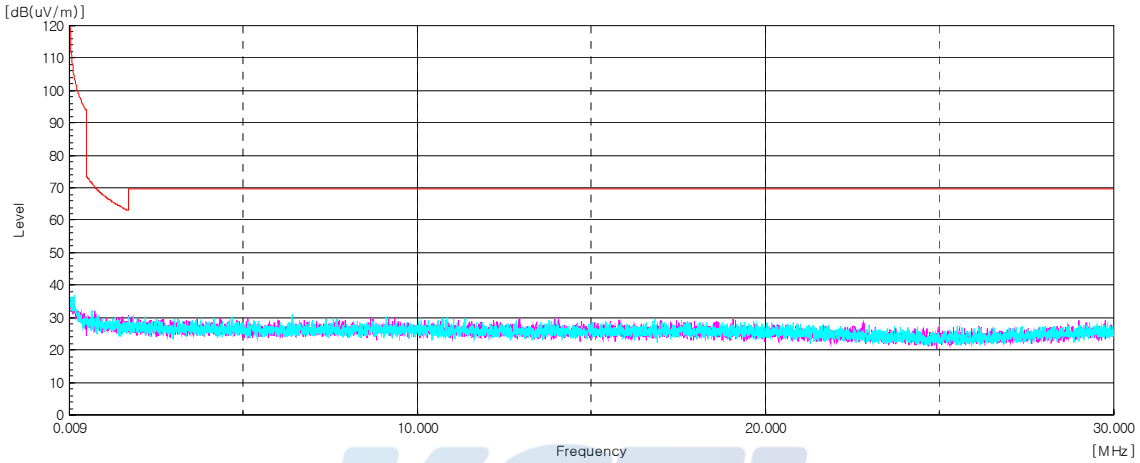
Test results (Below 30 ㎒) – Worst case: Half mode / Middle frequency

Frequency	Pol.	Reading	Cable Loss	Amp Gain	Ant. Factor	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
No spurious emissions were detected within 20 ㏈ of the limit.									

Horizontal/Vertical



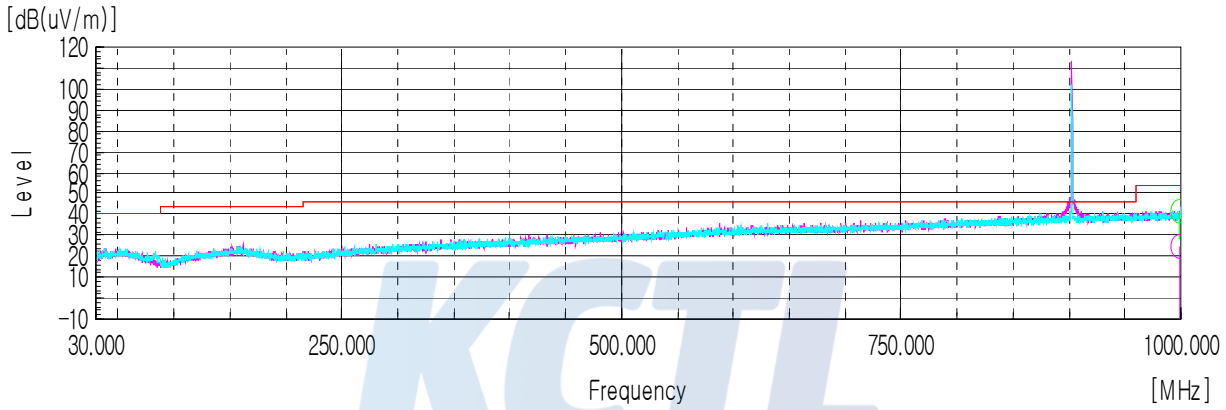
Test results (Below 1 000 ㎒)

Half mode

Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
999.15[1)]	H	20.90	22.60	-18.50	-	25.00	54.00	29.00

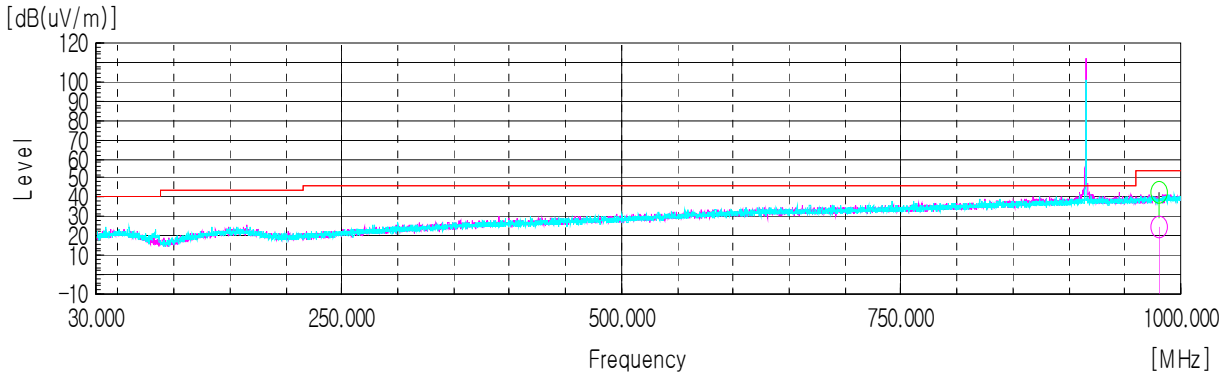
Horizontal/Vertical



Middle Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
980.48[1)]	H	21.30	22.52	-18.80	-	25.00	54.00	29.00

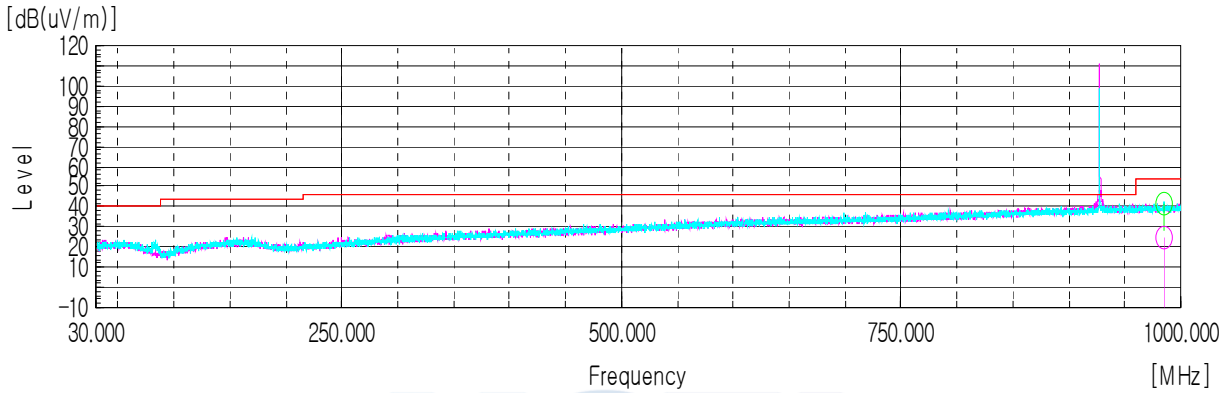
Horizontal/Vertical



High Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
985.57[1)]	H	20.60	22.54	-18.70	-	24.40	54.00	29.00

Horizontal/Vertical

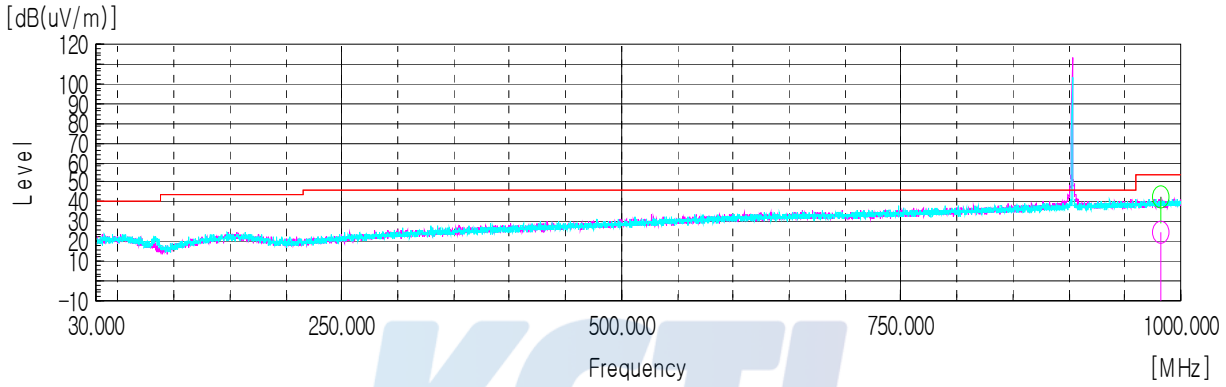


Hi-fi mode

Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
982.06[1)]	H	21.20	22.53	-18.70	-	25.00	54.00	29.00

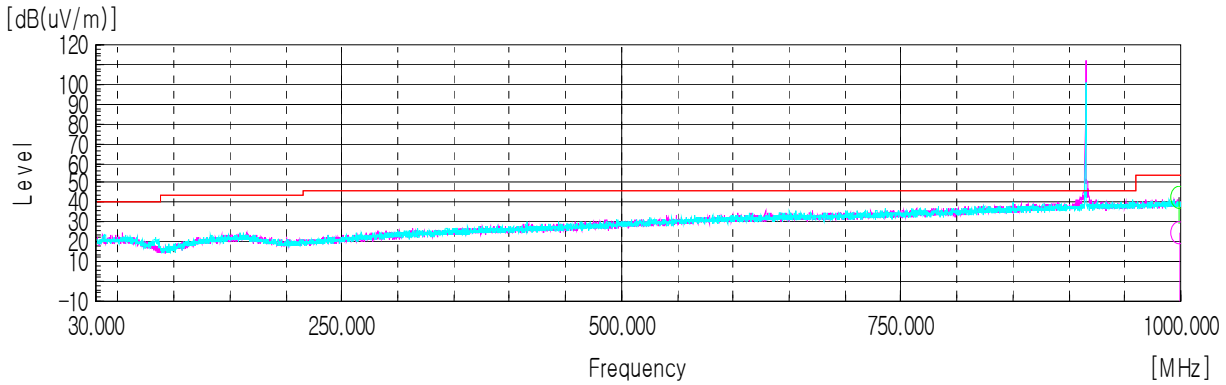
Horizontal/Vertical



Middle Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
998.42[1)]	H	21.10	22.59	-18.50	-	25.20	54.00	28.80

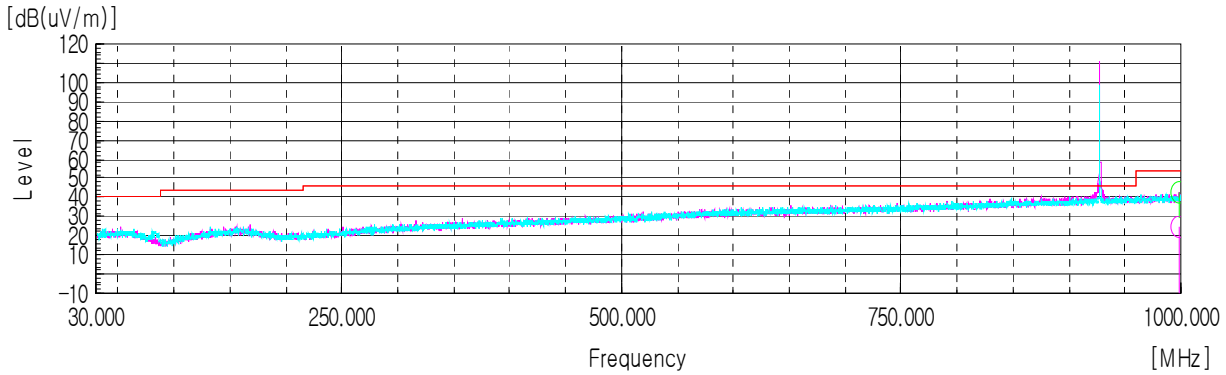
Horizontal/Vertical



High Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Quasi peak data								
998.06[1)]	H	20.80	22.59	-18.50	-	24.90	54.00	29.10

Horizontal/Vertical



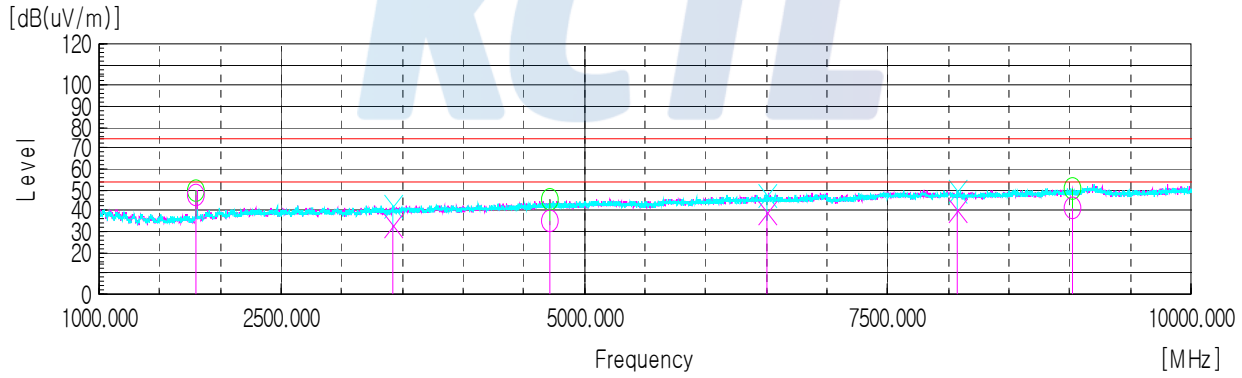
Test results (Above 1 000 ㎒)

Half mode

Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 804.38[1)]	H	48.90	30.44	-30.04	-	49.30	74.00	24.70
3 426.63	V	37.20	32.57	-27.27	-	42.50	74.00	31.50
4 721.50	H	35.90	34.54	-25.04	-	45.40	74.00	28.60
6 504.63	V	35.20	35.52	-22.92	-	47.80	74.00	26.20
8 076.25	V	34.30	36.18	-20.98	-	49.50	74.00	24.50
9 016.75	H	33.30	35.75	-18.85	-	50.20	74.00	23.80
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

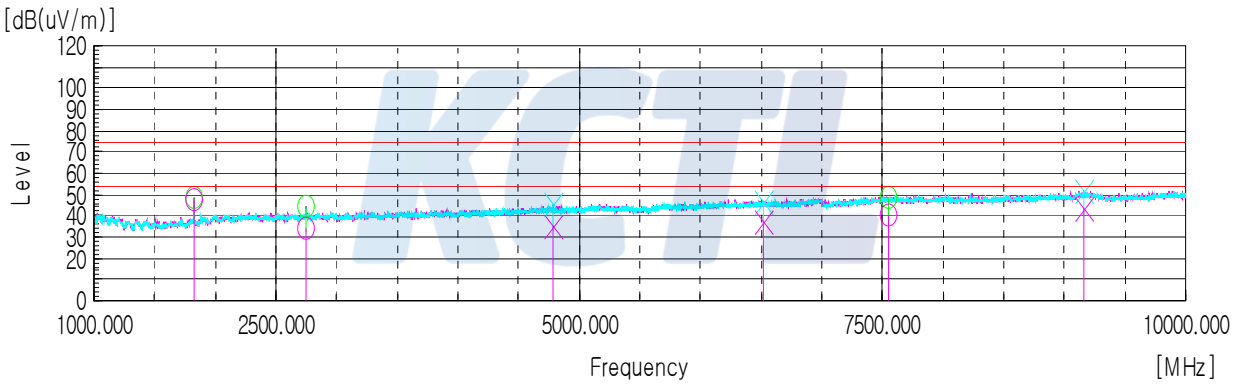
Horizontal/Vertical for 1 ㎓ ~ 10 ㎓



Middle Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 829.13[1)]	H	47.70	30.50	-29.80	-	48.40	74.00	25.60
2 744.88[1)]	H	39.60	32.11	-27.71	-	44.00	74.00	30.00
4 780.00	V	35.70	34.70	-25.30	-	45.10	74.00	28.90
6 519.25	V	34.50	35.52	-22.92	-	47.10	74.00	26.90
7 552.00	H	34.20	35.98	-21.08	-	49.10	74.00	24.90
9 166.38	V	35.20	35.95	-19.25	-	51.90	74.00	22.10
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

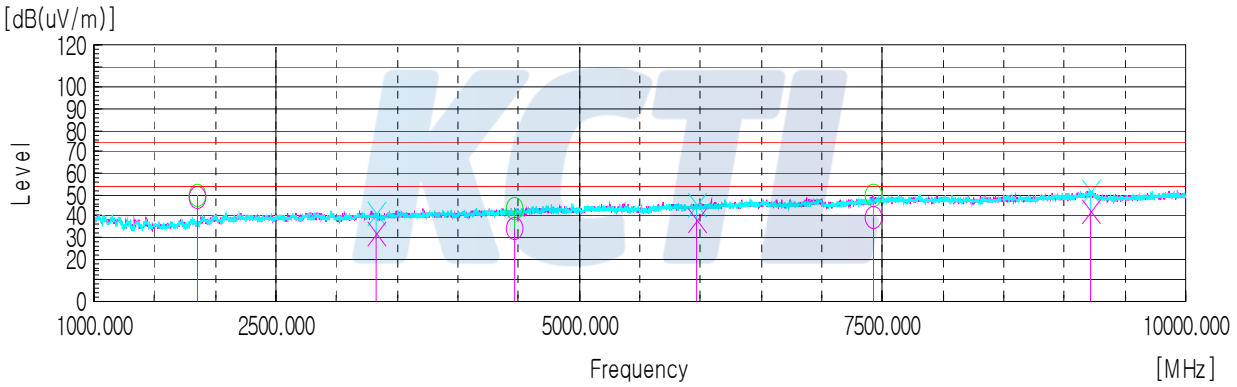
Horizontal/Vertical for 1 ㎓ ~ 10 ㎓



High Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 855.00[1)]	H	48.90	30.56	-29.56	-	49.90	74.00	24.10
3 329.88	V	36.60	32.56	-27.26	-	41.90	74.00	32.10
4 474.00	H	35.30	33.89	-25.49	-	43.70	74.00	30.30
5 968.00	V	34.10	35.34	-23.54	-	45.90	74.00	28.10
7 420.38	H	34.80	35.91	-21.21	-	49.50	74.00	24.50
9 212.50	V	35.20	36.01	-19.41	-	51.80	74.00	22.20
Average Data								
No spurious emissions were detected within 20 dB of the limit.								

Horizontal/Vertical for 1 ㎓ ~ 10 ㎓

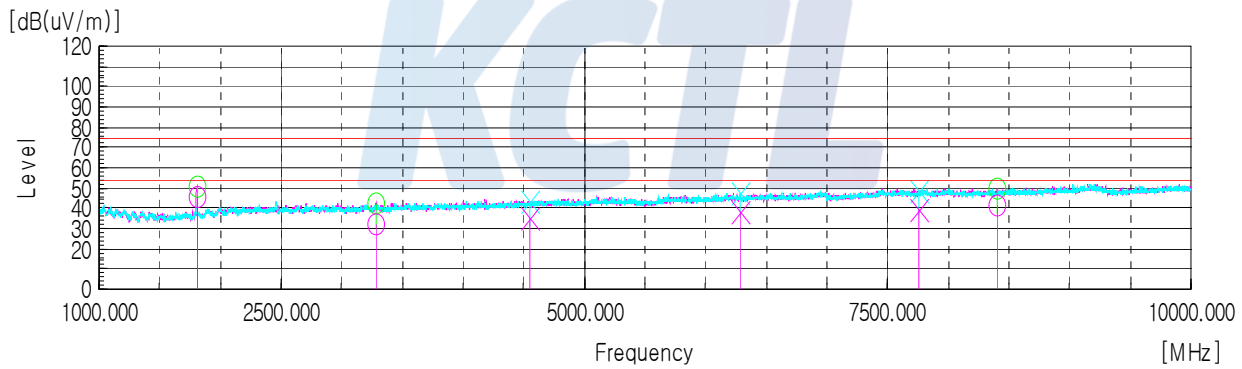


Hi-fi mode

Low Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 805.50[1)]	H	50.40	30.44	-30.04	-	50.80	74.00	23.20
3 283.75	H	37.50	32.55	-27.35	-	42.70	74.00	31.30
4 552.75	V	34.90	34.09	-25.09	-	43.90	74.00	30.10
6 280.75	V	35.40	35.44	-23.14	-	47.70	74.00	26.30
7 752.25	V	33.90	36.09	-20.99	-	49.00	74.00	25.00
8 398.00	H	34.30	36.02	-20.32	-	50.00	74.00	24.00
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

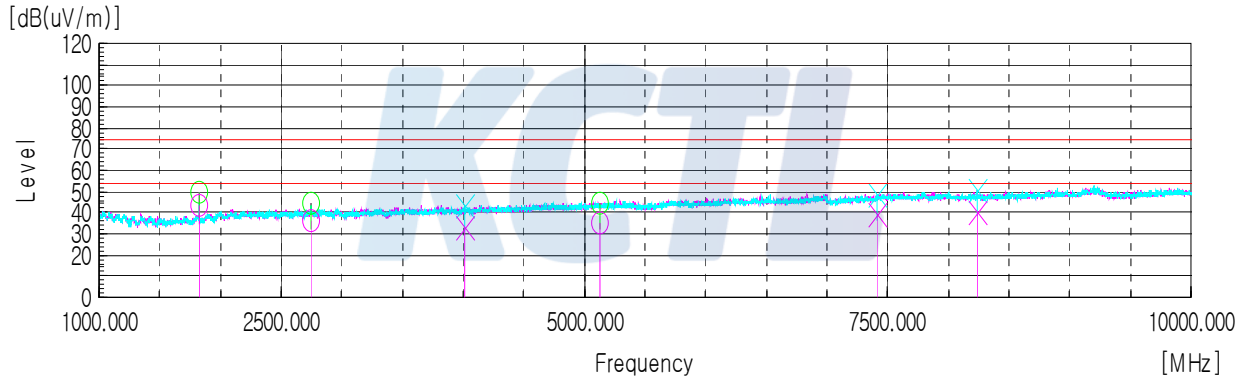
Horizontal/Vertical for 1 ㎓ ~ 10 ㎓



Middle Channel

Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 829.13[1)]	H	48.80	30.50	-29.80	-	49.50	74.00	24.50
2 744.88[1)]	H	40.00	32.11	-27.71	-	44.40	74.00	29.60
4 010.50	V	36.60	32.66	-26.06	-	43.20	74.00	30.80
5 124.25	H	34.80	35.29	-25.29	-	44.80	74.00	29.20
7 414.75	V	34.30	35.91	-21.31	-	48.90	74.00	25.10
8 234.88	V	35.20	36.10	-20.70	-	50.60	74.00	23.40
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

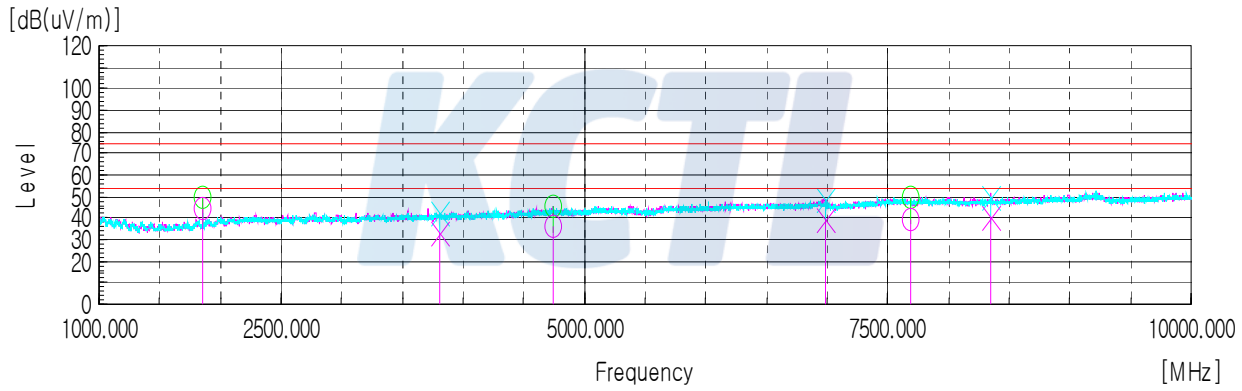
Horizontal/Vertical for 1 ㎓ ~ 10 ㎓



High Channel

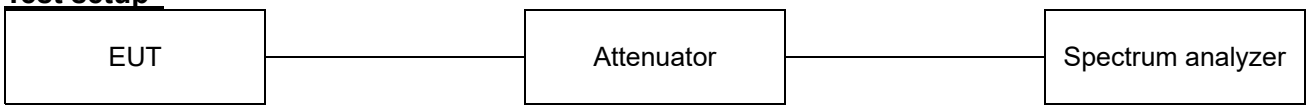
Frequency	Pol.	Reading	Ant. Factor	Amp. + Cable	DCCF	Result	Limit	Margin
(㎒)	(V/H)	(dB(㎶))	(dB)	(dB)	(dB)	(dB(㎶/m))	(dB(㎶/m))	(dB)
Peak data								
1 855.00[1)]	H	49.00	30.56	-29.56	-	50.00	74.00	24.00
3 806.88	V	36.20	32.61	-26.21	-	42.60	74.00	31.40
4 738.38	H	35.60	34.59	-25.09	-	45.10	74.00	28.90
6 980.50	V	35.10	35.68	-22.18	-	48.60	74.00	25.40
7 688.13	H	34.50	36.05	-21.05	-	49.50	74.00	24.50
8 347.38	V	34.20	36.05	-20.45	-	49.80	74.00	24.20
Average Data								
No spurious emissions were detected within 20 ㏈ of the limit.								

Horizontal/Vertical for 1 ㎓ ~ 10 ㎓



7.7. Conducted Spurious Emission

Test setup



Limit

According to §15.247(d), In any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operation, the radio frequency power that is produced by the intentional radiator shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation specified in §15.209(a) is not required. In addition, radiated emission limits specified in §15.209(a) (see §15.205(c)).
Limit : 20 ㏈c

Test procedure
ANSI C63.10-2013 - Section 6.10.4, 7.8.8

Test settings

- **Band-edge**
  1) Span : Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
  2) Reference level : As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log(OBW/RBW)] below the reference level.
  3) Attenuation: Auto (at least 10 ㏈ preferred)
  4) Sweep time = Coupled
  5) RBW : 100 ㎑
  6) VBW : 300 ㎑
  7) Detector : Peak
  8) Trace : Max hold

- **Spurious emissions**
  1) Span : 30 ㎒ to 10 times the operating frequency in ㎓
  2) RBW : 100 ㎑
  3) VBW : 300 ㎑
  4) Sweep time : Coupled
  5) Detector : Peak

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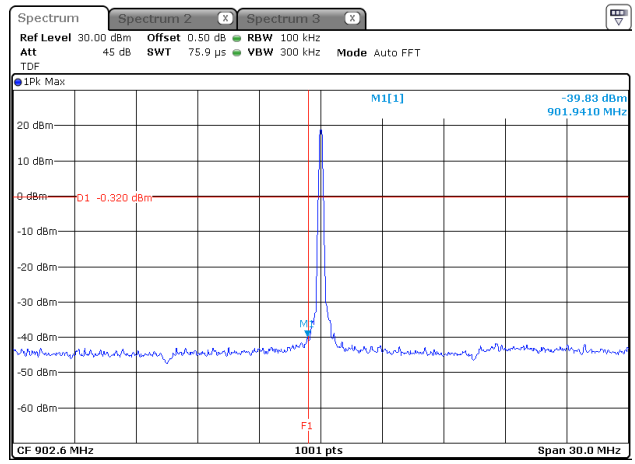
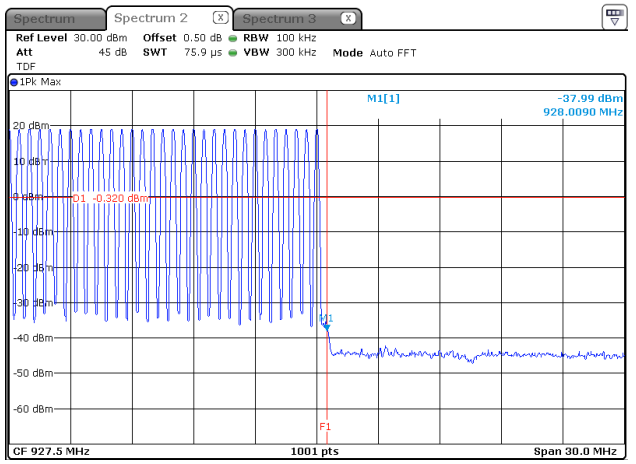
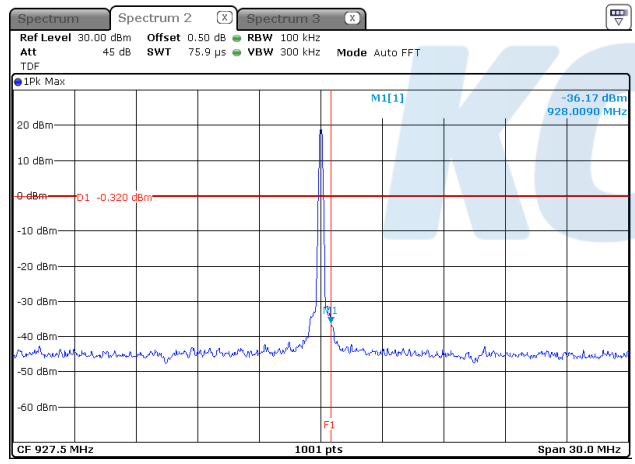
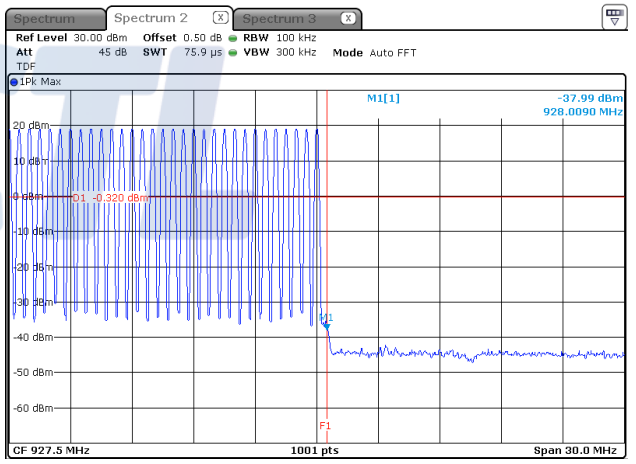
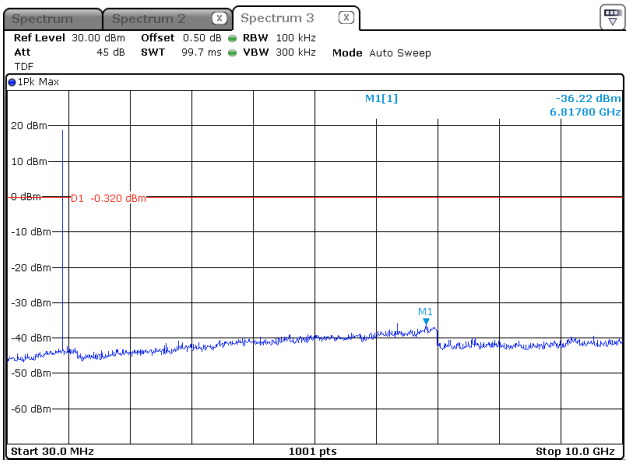
Test results

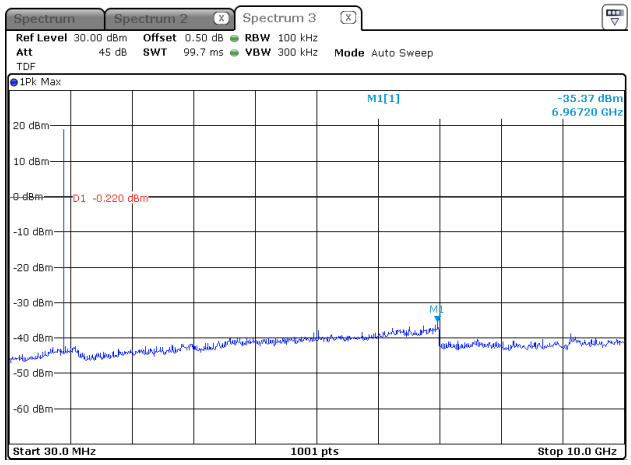
Half mode

Conducted band-edge / Low ch.	Hopping / Low ch.
	
Conducted band-edge / High ch.	**Hopping / High ch.**
	

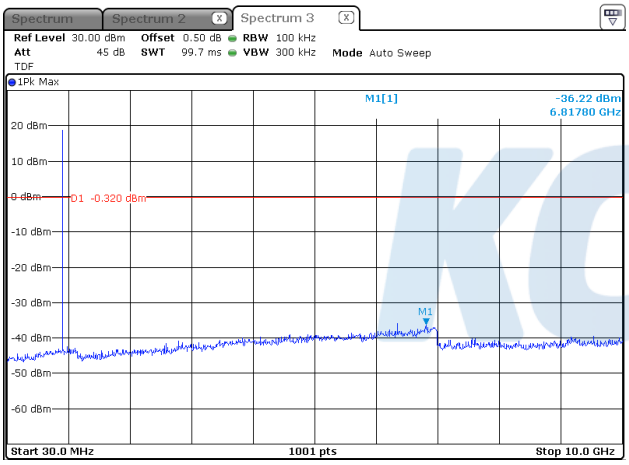
Conducted spurious / Low ch.



Conducted spurious / Mid ch.



Conducted spurious / High ch.



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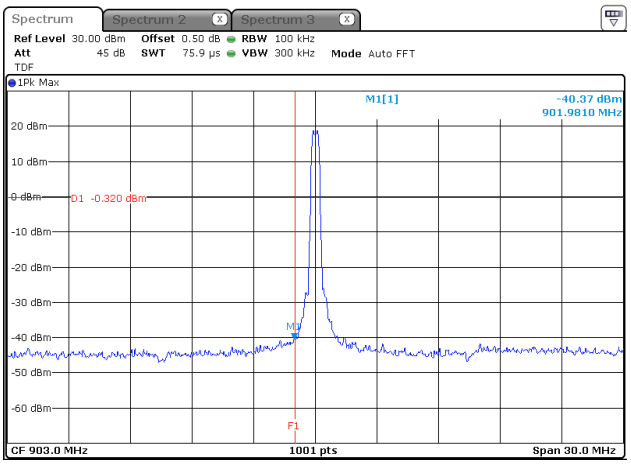
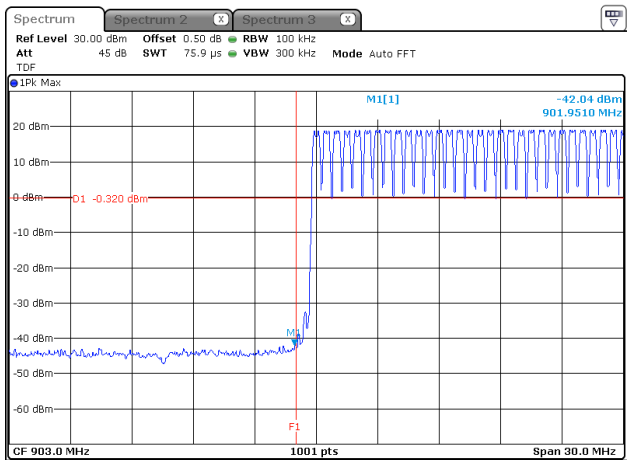
Hi-fi mode

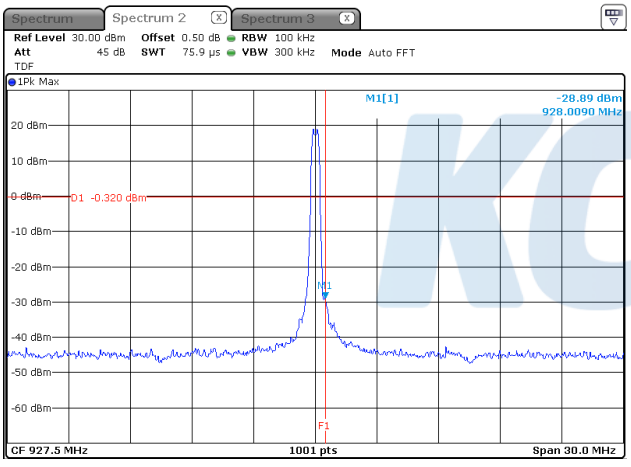
Conducted band-edge / Low ch.



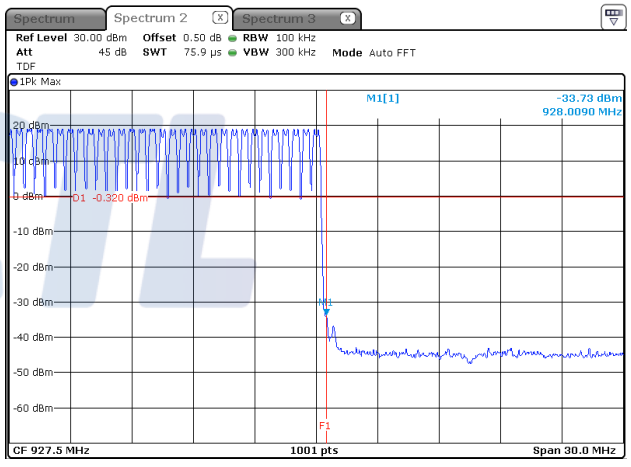
Hopping / Low ch.



Conducted band-edge / High ch.



Hopping / High ch.



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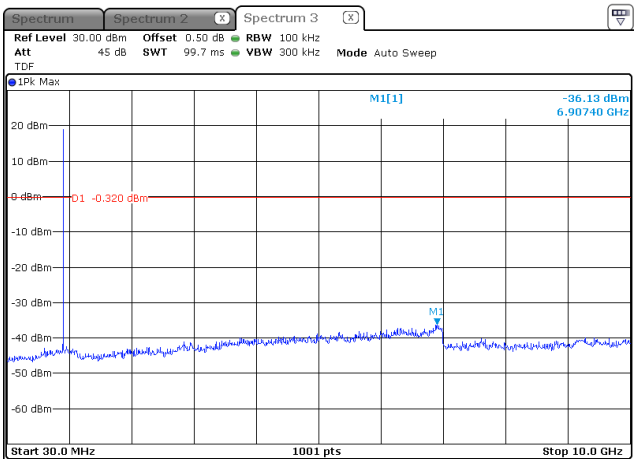
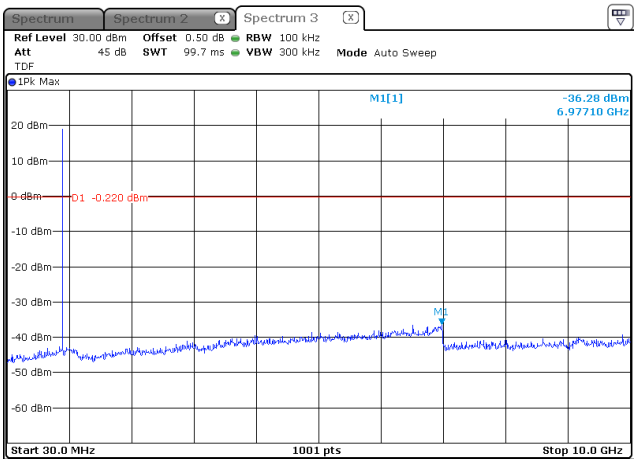
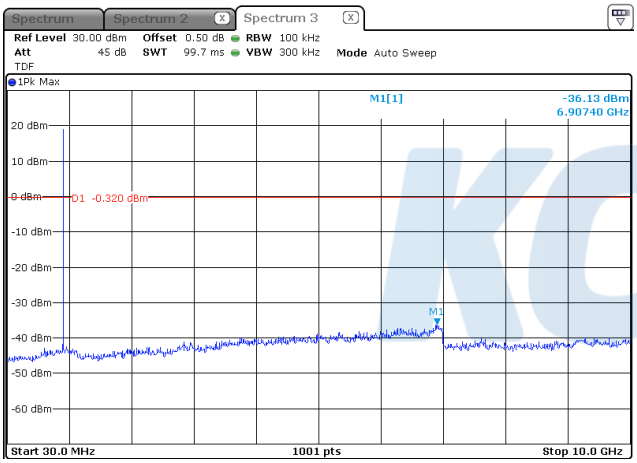
Conducted spurious / Low ch.



Conducted spurious / Mid ch.



Conducted spurious / High ch.



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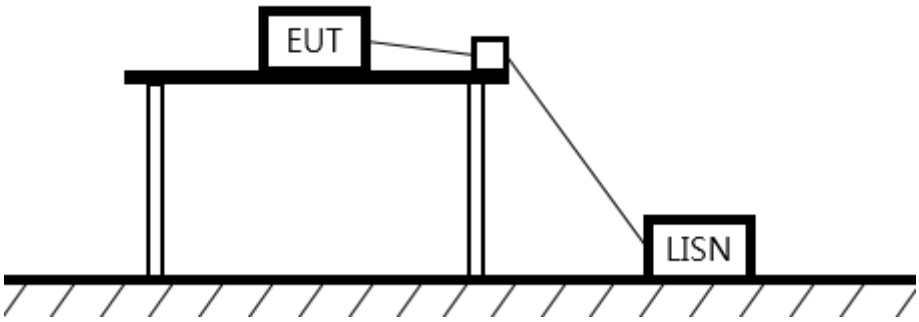
7.8. AC Conducted emission

Test setup



Limit

According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 ㎑ to 30 ㎒, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

Frequency of Emission (㎒)	Conducted limit (dBμV/m)	
	Quasi-peak	Average
0.15 – 0.50	66 - 56*	56 - 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

Measurement procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 ㎝ in which is located 40 ㎝ away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50μH LISN, which is an input transducer to a spectrum analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 ㎒ to 30 ㎒.
5. The measurements were made with the detector set to peak amplitude within a bandwidth of 10 ㎑ or to quasi-peak and average within a bandwidth of 9 ㎑. The EUT was in transmitting mode during the measurements.

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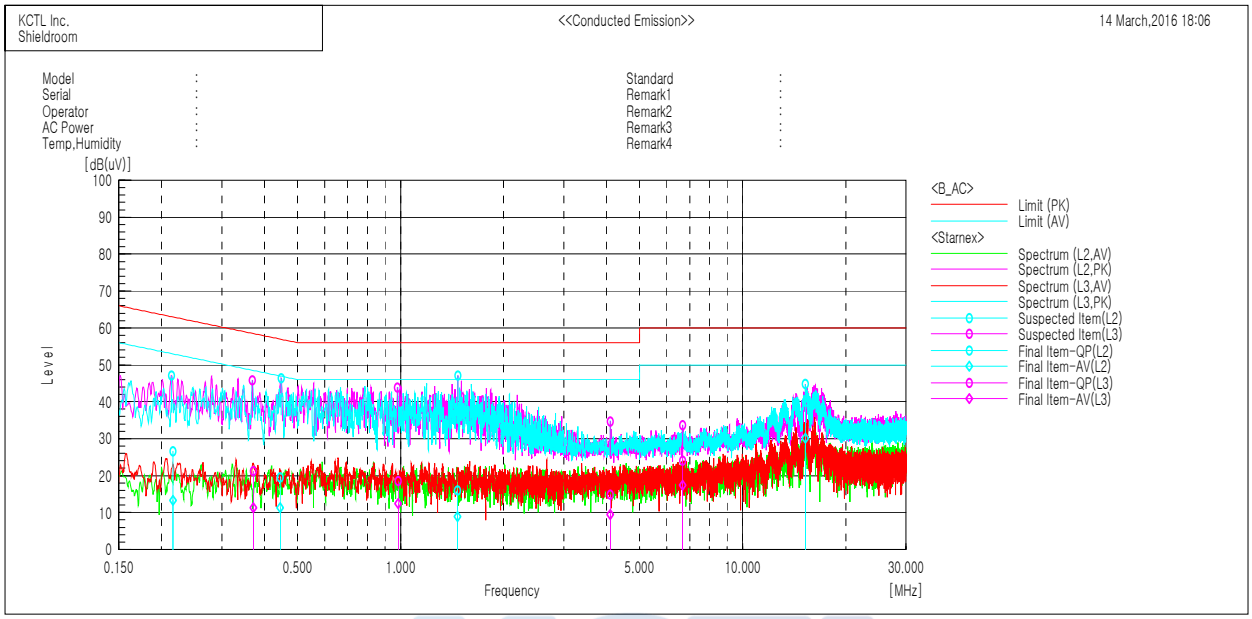
Test results

Worst case: Half mode Middle frequency



Final Result

--- L2 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.216	16.4	3.1	10.2	26.6	13.3	63.0	53.0	36.4	39.7
2	0.44501	9.3	1.1	10.2	19.5	11.3	57.0	47.0	37.5	35.7
3	1.46644	5.6	-1.5	10.4	16.0	8.9	56.0	46.0	40.0	37.1
4	15.25133	24.7	14.8	15.3	40.0	30.1	60.0	50.0	20.0	19.9

--- L3 Phase ---

No.	Frequency [MHz]	Reading QP [dB(uV)]	Reading CAV [dB(uV)]	c.f [dB]	Result QP [dB(uV)]	Result CAV [dB(uV)]	Limit QP [dB(uV)]	Limit AV [dB(uV)]	Margin QP [dB]	Margin CAV [dB]
1	0.37125	11.2	1.3	10.1	21.3	11.4	58.5	48.5	37.2	37.1
2	0.98409	8.3	2.1	10.3	18.6	12.4	56.0	46.0	37.4	33.6
3	4.09967	3.2	-2.1	11.6	14.8	9.5	56.0	46.0	41.2	36.5
4	6.67728	11.6	5.0	12.4	24.0	17.4	60.0	50.0	36.0	32.6

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8. Measurement equipment

Equipment Name	Manufacturer	Model No.	Serial No.	Next Cal. Date
Spectrum Analyzer	R & S	FSV40	100989	17.01.07
DC Power Supply	Agilent	E3632A	MY40017108	16.07.15
Signal Generator	R & S	SMR40	100007	16.06.15
Wideband Power Sensor	R & S	NRP-Z81	100677	17.01.08
EMI TEST RECEIVER	R & S	ESCI	100710	17.02.26
Bi-Log Antenna	SCHWARZBECK	VULB 9163	583	16.06.19
Amplifier	SONOMA INSTRUMENT	310N	344922	16.09.02
Attenuator	SCHWARZBECK	DGA9552N	BU2404	17.04.08
Horn Antenna	ETS.lindgren	3117	155787	16.11.25
Broadband Preamplifier	SCHWARZBECK	BBV9718	9718-233	17.01.09
LOOP Antenna	R & S	HFH2-Z2	100355	18.03.03
Antenna Mast	MATURO	AM4.0	079/3440509	-
Turn Table	MATURO	CO2000-SOFT	-	-
Highpass Filter	Wainwright InstrumentsGmbH	WHKX1.0/1.5S-10SS	14	17.02.04
TWO-LINE V-NETWORK	R & S	ENV216	101352	16.09.02
Vector Signal Generator	R & S	SMBV100A	257566	17.01.07

End of test report

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